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Regulatory Reform of the UK Gas Market - The Case of the Storage Auction

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August 1999

SEEDS 98
ISBN: 1852372257

Department of Economics
University of Surrey

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SEEDS 98

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ISBN: 1852372257
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British Library Cataloguing-in-Publication Data.
A Catalogue record for this book is available from the British Library

REGULATORY REFORM OF THE UK GAS MARKET - THE CASE OF THE STORAGE AUCTION

David Hawdon and Nicola Stevens

Abstract

The UK gas industry has undergone major changes since it was privatised in 1986 as a fully integrated monopoly. The most significant of these have occurred not as an outworking of the privatisation legislation but by the intervention of the ordinary competition authorities in support of an active industry regulator. While price capping continues to be used as the primary instrument for welfare protection against the still substantial monopolistic powers of the incumbent, new competition which has been positively encouraged, has had the greater impact on prices and choice. Recently, however, the regulator has encouraged the use of auctions for the sale of storage capacity. This paper considers the merits of auctions and makes a tentative evaluation of their effectiveness. Further use of auctions is recommended but reserve prices are considered inappropriate where monopoly power still remains.

Keywords: Gas Act, Ofgas, DGGS, Regulation, Auctions, Storage.
JEL Classifications: L51, L95, L97

1. The gas market and its analysts

The UK gas industry is of interest for two main reasons. In the first place it provides a large share of total UK energy supplies[1]. It is the largest supplier to the domestic or household market where gas is used mainly for space heating and cooking; and it occupies an important role both in the industrial and increasingly in the power station markets as a source of relatively low pollution fuel. But it is significant too in the changes that have taken place in its ownership and organisation in the post war period.

Originally based on coal, the industry remained small scale and locally based until 1949 when it was nationalised along with other industries in the fuel sector. It remained under state ownership until 1986 when the Gas Act returned it to the private sector as a privatised monopoly supplier - British Gas plc.

The subsequent history of the privatised industry has been well described as 'an excellent case study of the problem of regulating and restructuring a dominant, vertically integrated firm' (Armstrong, et al, (1994)) and a number of reviews cover the period well. These include Armstrong's own comprehensive analysis of the period up to 1994 covering the Gas Act 1986, early investigations of the industry by the MMC (1988 and 1993) and the OFT (1991) together with the development of price controls. Commenting on what they saw as the slow rate of progress towards a competitive market, they concluded that 'it is far better to achieve structural reforms to promote competition before an integrated monopolist is privatised' (Armstrong et al, 1994 p 278). Yarrow (1998) covers more recent developments like the extension of competition in all markets, the development of the network code by Transco governing competition in transportation. He argues that it has been the defining of rules of competition rather than structural changes in themselves, which have transformed the industry, and draws attention to the anti competitive nature of the network code. Waddams Price (1998) draws attention to the difficulties of extending effective choice to smaller consumers, and the potential for erecting barriers to entry when the incumbent exaggerates costs of supplying smaller customers, and argues for a greater focus on distributional issues. Davis and Flanders (1995) taking a different tack, examine the inconsistencies in regulation, and point to the costs of loss of genuine economies of scale by changes in the market position of British Gas. A study of the 1993 MMC report by Robinson (1994) is valuable for its explanation of the influential role of the Gas Council, the forerunner of British Gas as collector of North Sea gas field rents for the government which accounted for its monopsonistic behaviour towards gas producers, its lack of incentive towards efficiency and its influence on government ministers. Its strong bargaining position enabled BG in 1986 to emerge from the privatisation process as a vertically integrated monopoly supported by

[1] 36% of total inland energy consumption of primary fuels in 1996. The others are petroleum (34%),

protected markets and long term supply contracts. Despite their differences of approach the earlier commentators agree on three points:-

- Privatisation of the gas industry in 1986 did little to promote customer welfare directly by lowering prices or increasing output availability
- Initiatives by the ordinary competition authorities (the MMC and the OFT) in support of the industry regulator were nevertheless successful in limiting the market power of British Gas and in extending competition to industrial and domestic markets. The benefits of competition have been outstanding, both in terms of market entry and in benefits to customers.
- BG rather than being broken up has survived remarkably well as a group of separated but not divested companies under common ownership and it retains significant market power in some markets notably transportation and storage.

Given that the early period of the industry's development since privatisation is already well covered, we will focus on more recent developments, which seek to achieve the goal of competitiveness in the gas market through the use of auctions. Auctions have had a chequered history in the gas industry. Although they were advocated by Kenneth Dam and Colin Robinson as far back as 1976 (Robinson, 1994), as a way of allocating North Sea gas exploration and production licences. This proposal was rejected by a government preferring a more discretionary and interventionist approach to licence awards (for example preferring domestic over foreign oil companies). Yet auctions had been extensively used in the USA for oil leases, and a literature discussing their efficiency properties had been available since 1971 (Klemperer (1999)). Academic discussion of auction issues flourished during the 1980s when many fundamental features of auctions including the influence of auction design (first price, second price and so on) and assumptions about independence or common values were thoroughly explored. However, it is not until quite recently that auctions have come to be accepted as an effective means of attaining social objectives within regulated industries. The success of auctions in raising public funds both in the USA (particularly in the case of the radio spectrum auctions, on which see McAfee and McMillan (1996)

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coal (19.9%) and nuclear electricity (9.5%). See DTI (1998) and in the UK's own sale of privatised assets, has encouraged their use in areas previously thought unsuitable. But before we consider the use of auctions more fully, it is important to review the changes that have already been made in gas industry structure.

The changes that have already been made

1. Significant entry has occurred. Prior to nationalisation in 1948, there were 1046 companies in the gas industry, consisting of a mixture of private and municipal firms (Armstrong, 1995). Under nationalisation this shrank to a unified industry divided into a Gas Council and 12 Area Boards. Today the industry consists of 27 domestic gas suppliers, 61 industrial gas suppliers, 58 shippers, and 7 public gas transporters (PGTs)

2. Prices both in industrial and in domestic markets have fallen in real terms. Industrial gas prices began to fall after 1986, while domestic prices have only recently showed signs of substantial reduction.

3. Sales of gas have continued to rise throughout the 1990s both absolutely and relative to energy demand as a whole. This suggests that the objective of regulation to control market power has been largely successful

4. Nevertheless, overall efficiency of the UK gas industry is only slightly above average for Europe as a whole. Data gathered by Eurogas (European Union of the Natural Gas Industry) ranks the UK 6th out of 16 countries in terms of output per employee but only 9th in terms of sales per kilometre of pipeline. Allowing for differences of definitions between countries, these comparisons suggest that the UK still has someway to go to attain relative efficiency in gas transmission and distribution[2]

2. The Role of Storage in the UK Gas Market

The ability to use storage economically has long been recognised as an important difference between the gas and electricity industries (Bates and Fraser, 1974, p 138). Storage enables better co-ordination between supply and demand so that a constant supply can be better fitted to a varying demand e.g. in peak times. According to Rees (1984), 'storage permits a higher level of consumer benefit ..not only because it permits utilisation of off-peak capacity which might otherwise lie idle , but also because it enables a degree of arbitrage, transferring consumption from the period in which its value is low to that in which it is higher, to an extent determined by the costs of storage' (p.113). In addition storage has a function in coping with stochastic events and is valuable in improving the safety of a system[3]. Storage enables a gas system to cope with two recurring problems - diurnal (daily) demand swings, and seasonal variations in demand.(Ofgas, 1998).

It is perhaps helpful in understanding the role of storage to consider the short run supply choices available whenever customers increase their demand for gas at a particular location. The supplier may

- increase compression to overcome the pressure drop,
- raise operating pressure by increasing offtake from a terminal near the source of demand (swing supply),
- extract gas from storage with a similar effect on operating pressure, or
- reduce demand elsewhere by shutting off interruptible customers. [4]

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[2] France is over 5 times more productive in terms of sales per employee, while the Netherlands is around 10 times as effective in generating sales per km of pipeline.

[3] Bates and Fraser mention three functions of storage - co-ordination, regulatory and safety. We have grouped the first two together under co-ordination.

[4] This follows from an engineering equation determining flows of gas through a pipeline, $Q=k.D^{2.53}[P_1^2-P_0^2]^{0.51} L^{-0.51}$, where D is pipeline diameter, P_1 is inlet pressure, P_0 is inlet pressure, L is the pipeline length, and k is a constant. The difference in inlet and outlet pressures occasioned by an increase in demand is overcome by compression using gas turbines or new supplies. (see Banks, 1984)

Being able to juggle between these options provides several economies to an integrated supplier. These are:-

- Diversity benefits whereby individual user's peak demands and supplies may are offset against each other to produce a smoother load profile. The system peak demand is less than the sum of the peak demands of all customers.
- Increased security of supplies in case of interruptions or failure of components of the transport system. Alternative routes through the transmission network are available in emergency. This is rather like the security provided by the Internet to computer users.
- Information economies resulting from integrated customer relations (one phone call for anything). The gas transportation system responds to signals arising from pressure changes at various nodes and does not require information on every customer.

Why should the provision of storage be regulated? There are two potential welfare-reducing consequences of under provision of storage - higher peak/off peak pricing differentials, and/or over investment in production and transmission facilities. Customers with high winter demand relative to annual usage are worst affected because of their high relative needs for capacity investment. In addition, storage can provide competitive firms with a means of reducing costs of balancing peak/ off peak requirements and so help to attract entry to the industry.

How would unrestricted access to storage help to reduce costs? Suppose the amount of storage demanded was less than the amount available in the short run. Then marginal storage costs would set an upper bound to peak day costs. Peak costs would not exceed the sum of marginal production plus transportation costs and marginal storage costs. On the other hand if the demand for storage exceeds the availability of storage, the price of storage will rise. Since storage is now more expensive production will shift away from the off peak towards the peak period where output is more valued. Storage moderates the change in peak prices which would otherwise need to be made to achieve the same effect. The introduction of competition into the provision of storage services will improve consumer welfare if it brings down storage costs.

Since storage is so closely related to the needs of the entire transportation system for gas, would it not be better to leave it integrated with transportation? Certain uses of storage are indeed complementary to transportation. These include the provision of operating margins for safely running the system in the event of equipment failure or weather changes; 'Top-up' gas for meeting demand when beach supplies are inadequate in extreme weather; balancing margins for coping with temporary problems in the working of the flexibility mechanism; and diurnal storage to cover daily variations in demand. But storage is not the only way of meeting these requirements - for example, interruptible sales can be reduced in extreme weather and beach swing provides some flexibility during off peak periods in particular. The existence of these alternative sources provides the basis for the claim that storage functions in a potentially competitive market, and that competition can have efficiency benefits for users of these services. In addition, even within the storage sector proper, facilities differ widely in their capacities for storing and releasing gas. Where storage facilities are not homogeneous, competition will allow comparative advantages to be discovered so that an efficient mix of provision is made.

In the UK, diurnal local storage is provided by Transco in the form of low pressure gasholders, linepack and high pressure storage plant. Large scale national facilities consist of a former gas field, Rough, salt cavities at Hornsea, and five LNG facilities. They differ in terms of storage capacity, injection and withdrawal rates and so are suitable for different purposes. Rough with its large capacity but slow withdrawal rates is suitable for seasonal storage, Hornsea is smaller but has faster input/output times, and the LNG sites have the most rapid rates of deliverability and are suitable for short periods of high demand.

2.1 Regulatory control of storage.

Although the Gas Act 1986 did not provide specifically for the licensing of storage as a separate activity, a storage provider needed a PGT licence to convey gas through pipes. Between 1990 and April 1997, storage was subject to the same price cap control as transportation. Then in April 1997, storage and transportation were unbundled and a separate price control applied to each. New opportunities for competition both between storage facilities and with European gas via the interconnector with Belgium opened in 1998.

Table 1

UK Gas Storage Facilities, 1998

Facility	Space	Deliverability	Injection
	GWh	Gwh/day (% of peak gas at beach)	GWh/day
Rough gas field	30,344	455 (8.8%)	160.0
Hornsea salt cavity	3,495	188 (3.6%)	21.4
LNG sites (5)			
Avonmouth	827	165 (3.2%)	2.6
Dynevor Arms	276	55 (1.1%)	2.9
Glenmavis	827	165 (3.2%)	2.5
Isle of Grain	1213	243 (4.7%)	5.4
Partington	1195	239 (4.6%)	5.2
Peak beach flows		5191	

Source: Ofgas (1998) p.14

2.2 The MMC Report, 1993

Dissatisfaction with BGs failure to implement a commitment to the Office of Fair Trading to separate its transportation and storage business led the DGGS to refer the matter to the MMC in 1993. In its evidence to the MMC, British Gas argued for an integrated transportation and storage system. BG divided customers into core customers - largely weather sensitive and domestic customers - for whom safety was such a priority that provision of choice would be costly and unnecessary. Core customers also faced the risk of shipper default. They would therefore benefit from a common level of security. Above this level, customers could bear the risks themselves. However, because BG judged that this cut off level was at 100,000 therms, a mere 9000 sites were left for independent shippers to supply. The MMC considered that ultimately the argument was about BG's capacity to curtail consumption by defaulting shippers. The implication for storage was the almost all Rough, Hornsea and LNG storage capacity would be reserved for core users.

The consequences of such an approach were seen by the MMC to be

- stifling the development of a competitive market in storage supplies
- that BG rather than the shipper bears the risks of inadequate storage
- strict controls on non core users.

Another issue was the bundled services which BG preferred. to sell at fixed prices to shippers. These bundles offered different amounts of peak and seasonal storage. Shippers would have no operational control e.g. of the location of the storage they obtained - that would remain in the hands of BG who would run it in such a way as to maximise system efficiency. Contracts would govern such matters as peak day withdrawal, injection and storage entitlements and would be enforced by penalty charges.

BG was criticised by Ofgas for not allowing customers to choose the level of gas service they wanted or shippers to choose between different ways of meeting customer demand. Thus the transporter not the shipper controlled the provision of supply thereby hindering the development of competition. Next, discrimination in favour of the trading arm of BG was possible, erecting barriers to entry by setting excessively costly requirements for competitors. The MMC considered that under the proposals BG T&S would have a monopoly position in the supply of gas transportation, balancing and storage.

Following the publication of the 1993 MMC report a number of significant changes occurred in the structure of the industry. Although the MMC had recommended divestment, the government decided in December 1993 merely to separate transportation and storage. In 1995, a new Gas Act implemented competition in domestic sales on a rapid timetable. Then in August 1996, the DGGS recommended separate price caps for storage and transportation, and also a reduction in transport charges of 20% in real terms and a reduction in investment. BG rejected the proposal, and the matter was referred back to the MMC in October 1996. Between the referral and the report (May 1997), BG demerged into Transco (transportation and storage) and Centrica (trading and some production).

The MMC's report approved the need for separation of storage from transportation, and that separate price caps would be a first step in unbundling the services. Under the DGGS's proposals, separate price caps were set for storage and transport.

2.3 The 1997 MMC Report)

The DGGS' proposals included separate price caps for storage and transportation, an initial substantial reduction in Transco's charges (20%) followed by a more stringent X efficiency control. A clear distinction was made between storage which was potentially competitive and transportation which was not. Potential competitors had indicated their desire to build competing storage facilities (MMC, 1997, p13). The main problem with the current price control was that it allowed Transco to compensate any loss of revenue from storage competition with higher revenues from transportation. The MMC judged that this would be likely to operate against the public interest. BG had argued that the effect of unbundling storage would be a loss in the value of its assets and demanded compensation for stranded assets. Its case was rejected rightly by both the DG and the MMC on grounds that asset values may rise as well as fall post unbundling and if asset values rose the problem would disappear. subsidisation.

BG had applied to disapply price control from storage. The MMC ruled that some form of regulation at least in the short term was necessary because of BGs market power at peak periods when there was as yet no effective alternative supplier of storage. A compromise was reached whereby the control would be reviewed after three years.

Separate price controls for transportation and for storage were implemented in 1997. At this point, however, serious discussions were held on the potential use of auctions to replace the existing price cap regulation for at least part of storage. The next section considers the general arguments in favour of auctions while section 4 relates them to gas storage.

3. Auctions and their uses

Auctions are stylised markets with well-defined rules, and can raise revenue quickly. In addition they have several informational advantages. They can be used by sellers to extract information from buyers as to their valuation of goods. Auctions are allocatively efficient in that if the bids reflect the true valuation of the bidders and the item is sold to the bidder with the highest valuation then the welfare gain from the transaction is maximised. Thus for goods with unknown or highly uncertain value such as works of art or indeed gas storage in a changed market structure, an auction may be an efficient way of valuing and allocating the good. Whether this happens in practice depends upon the nature of information held by the bidders, the type of auction carried out, and the degree of collusion possible either between bidders or between sellers/ auctioneer and bidders.

Where the value of the item is truly unknown, so that each bidder has an independent valuation, it can be shown that the standard types of auctions are 'revenue equivalent' or yield the same expected revenues from the winning bid. In the English (ascending bid, first price, open cry) auction where the highest bidder wins the object and pays his bid, the winner's payoff is his value minus his bid. Bidding ends when the price reaches the valuation of the player with the second highest valuation. So if the first player values at 100 and the second at 90, the auction will end when the bidding rises to $90 + \varepsilon$, where ε is a small increment in the bid. The winner wins $100 - 90 - \varepsilon = 10 - \varepsilon$. This is because the winner prefers to pay the lowest possible price, and will always bid if the object's price is less than its value to him. Her strategy is a function of her valuation, her prior estimate of the other bidders' valuations, and the past bids of all the players. She can therefore update her information set. The outcome is, however, affected by procedures adopted by the auctioneer to raise prices between bids, and it is assumed that each bidder knows her own valuation with certainty.

A second type of auction is the first price sealed bid auction. Here the player's strategy is a function of the player's value and prior beliefs about other players' valuations. In this case if the player is not sure about the second highest bid, a number of outcomes are possible which depend on risk neutrality, and beliefs about other bidders. This has a less robust equilibrium than the English auction. For the case of N risk neutral bidders, each should bid (N-1)/N. v + ε, i.e. (N-1)/N times his own value plus ε. It can be seen that the greater the number of bidders the more closely the winning bid approaches the true value of the highest bidder. However, this is not always the case and examples can be constructed where the winner can be paying many times more than is required.

Vickrey type auctions (after Vickrey, 1961) are second price sealed bid auctions where the winner pays the amount of the second highest bid. In equilibrium, each player bids his value and the winner ends up paying the second highest bid. Vickrey auctions are not widely used except in foreign exchange and credit markets, but do possess attractive features.

Dutch auctions are auctions in which the price is lowered successively until the first bidder appears. Although the seller's expected price is the same in all auctions, the variance of prices is more severe in the Dutch auction and the risk averse seller should use the English auction. Dutch auctions are used in flower and tobacco markets and in time discounted sales items.

It can be shown that all forms of auction are revenue equivalent (Klemperer, 1999) and are Pareto optimal in the sense that the prize is expected to end up in the hands of those who value it most. This is Vickrey's (1961) revenue equivalence theorem. The result is dependent, however, on risk neutrality (risk averse bidders will increases the bid slightly to ensure a win), and potential for collusion. Thus a first price sealed bid auctions may be preferred to an English auctions where collusion is feared.

The second type of information assumption - that there is a true but unknown value - may be a more accurate representation of items used as inputs in the production of market goods. Thus the value of oilfield licences may be estimated from the market for oil. The existence of a common but unknown value can produce the so called 'winners curse' in common value auctions. Suppose the value of the object is not known with certainty to the bidders, but is believed to lie in the range v1 to v2. Then there will be a distribution of values some lower some higher than the true value. Bidding will proceed until the one with the highest valuation wins. But this will be the one with the most optimistic valuation. 'Anyone who wins against experts should worry about why they all bid less' (Rasmusen, 1994, p.300). Examples of the winners curse are difficult to find but it has been (wrongly) blamed for poor performance of US oil tracts bid for in the 1960s.(Clapen, Clapp and Campbell (1971). To some extent the problem can be avoided by each bidder revising downwards his bid by an amount y where y is the difference between his valuation conditional upon his winning and his losing the auction. Sellers can raise the general level of bids by disclosing all relevant information; this reduces bidder uncertainty and mitigates the winner's curse.

Again, a problem known as the holdup problem can arise when quasi rents exist following the implementation of a contract. Quasi rents occur where the ex ante and ex post opportunity cost of capacity needed to supply a buyer are unequal. This might be because a buyer sinks some costs after the auction, for example by locating near a specific storage site. An efficient auction of capacity will lead to the transfer of rent from the purchaser to the seller, leading to ex ante efficiency. However, where sunk costs are made, the seller has an incentive to exploit her power by attempting to raise prices ex post, by renegotiating the contract. This increases the cost of the whole operation, and may deter buyers. If the buyer factors in the ex post renegotiation cost, he is likely to offer less at the initial auction stage, and where reservation prices are enforced by sellers, a suboptimal quantity of storage is likely to be contracted. The net effect may be less cost reducing investment, more investment designed to improve ex post bargaining positions and a loss of trust. Defining k as the degree of specificity of capacity, Besanko et al show that the higher is k the less likely are cost reducing investments to accur, since the more quasi rent is available to be negotiated away. (Besanko, et al 1996, p.116 and 132).

When possibilities of collusion exist, the options are no longer equivalent. If for example, collusion is feared amongst bidders, the Dutch or first price sealed auction may be preferred because it maximises the chances that the ring will break, in the case of the Dutch auction before the designated winner's bid. If on the other hand collusion is feared between the auctioneer and a crony, an English auction may be preferred.

Where there is risk aversion among bidders, this also affects the desirability of the various auctions. The Dutch auction will be preferred by the seller because of the reluctance of risk averse bidders to lose the auction, and therefore their willingness to bid high. Correlated bidding results in preference for the English auction, while relaxing assumptions like those of symmetry, single unit auctions, or no participation fee /minimum reserve prices will lead to substantial changes in predicted performance of the different auctions.

3.1 Experience in the US

Here auctions have been held for leases for the rights to develop gas and oil reserves, pipeline capacity, commodity trading, and for disposing of costly gas. Lease auctions were the earliest and were designed to award private firms the rights to develop resources on government lands. They are sealed bid first price, simultaneous auctions involving a lump sum for the rights, where the winner also pays royalties and rental payments as specified in the auction announcement. (Holmes, et al, 1998). Bids for different tracts[5] have to be made together, including a 20% deposit to deter spurious bids. Reserve prices and minimum bids are enforced and all information is made public after the winning bid is announced. The reserve price takes account of the likelihood that not all buyers are well informed and is often based on the government's own valuation of the tract.

More relevant to recent UK developments are the auctions for capacity release. Here releasing shippers (one with firm contracts for capacity on a pipeline) auction capacity of other shippers (called replacement shippers). The FERC requires that all such releases be posted for bidding electronically with certain exceptions, but that releasing shippers may designate a replacement shipper to match the winning bid and receive the

[5] Tracts are typically 5000 acres

capacity. Although a first price progressive auction is used, prices are subject to maxim set by the FERC, and the releasing shipper may state a reserve price.
Interstate pipeline auctions are fairly recent and are designed to avoid affiliate i.e. tied company, abuse. To date only one such auction is contemplated and is currently before the Commission[6]

Supply auctions are used to dispose of costly gas. Here bidders have to be paid to take the gas, and bids proceed from highest to lowest. This 'reverse auction' approach has been used for gas supply realignment when contracts have been terminated under regulatory orders. Pipelines are allowed to recover the winner's price from customers.

The results of these auctions encouraged the FERC in July, 1998, to propose auctioning all short-term capacity (Holmes et al, 1998) and to discuss which type of auction may be most effective.

4. Auctions and Storage

Prior to 1999, gas storage services were sold on the basis of three capacity components - space, injectability and deliverability. Space is the total amount of gas that the facility can hold when full, injectability is the rate at which gas can be put into the facility and deliverability is the rate at which gas can be withdrawn from the facility. For Rough and the LNG services prices were published in advance. Storage offered at Hornsea was sold on a different basis. Part was sold by fixed prices, the remainder by an auction process. In the event that Hornsea was oversubscribed, it would be booked out to the highest tenders. Successful tenderers would then receive their booking at the market clearing price (not the price they bid).

The fixed prices were derived as follows. BG Storage calculates revenue targets for the injectability, space and deliverability service at each site and the targets are scaled to ensure the total revenue is in line with current regulations. The revenue targets for space and injectability are added together to give a revenue target for space with

[6] Proposal filed by the Natural Gas Pipeline Company of America (FERC, 1998)

injection rights. Targets for space with injection rights and deliverability are then converted into prices by dividing the total revenue targets by the capacity. Up until April 1971 the target revenue was the cost of providing the service, including a regulatory return on assets. Following the 1997, MMC report, BG Storage calculated the revenue target consistent with the new revenue cap set for transportation and storage.

Three main concerns arise over this method of pricing for storage services. In the first place, at times of high demand (during the winter period), demand for storage services is price inelastic and this provides an incentive to price at above marginal cost. BG Storage revenues did in fact exceed its maximum allocated revenue by 4% in 1997/98, and suggested prices for 1998/99 would if all capacity were booked, lead to substantial over recovery in this year. That prices are too high is supported by simulation work reported by Stevens (1999).

Secondly, consistently high amounts of capacity remained unbooked at Hornsea following the part set price part auction process. In 1997/98, 33% remained unbooked while in 1998/9 this increased to 37%.

Thirdly, the rigid ratios in which bundles of service characteristics are sold limits the demand for storage. Whilst this is disadvantageous to customers, it is consistent with monopolistic behaviour on the part of the seller.

Before we consider the new auction proposals a preliminary evaluation is possible for the Hornsea part auctions. The auction component was a second price sealed bid auction for deliverability; space having already been sold at a fixed price. We can evaluate it on two grounds - revenue raising and efficiency. In terms of revenue raising the results are significant. According to BG Storage the market clearing price and the revenue maximising price were identical at 3.709 p/pdkWh/annum indicating that the Hornsea auction did indeed raise as much as it could have done. However, in terms of efficiency, the result is quite different. Assuming that the BG Storage's guide price of 3.050 p/pdkWh/a accurately reflects its storage costs, substantial profits were made at the auction and output was too low. Finally, however, it should be noted that the auction was quite popular amongst shippers as it provided a way of price discovery for the first time. Shippers did not object to the extension of auctions to the Rough facility in the 1998 Ofgas proposals.

The major advantages of auctioning larger amounts of storage were seen by Ofgas to lie in more efficient utilisation of storage, more accurate price discovery, reduction of risks through smaller price variation, and encouragement of competition. Ofgas proposed a mixture of five and one year auctions for both Rough and Hornsea storage. The form of the auction was a sequential, two dimensional (price and quantity), multi-attribute, second price auction in which 50% of Rough and Hornsea capacity would be auctioned on a 5 year basis, while the remainder would be auctioned on a 1 year basis. The price charged is the bid of the last bidder to receive an allocation. Capacity is offered in bundles of attributes (injectability, space and injectability)[7] whose proportions are fixed in advance, in lots of 5000 cu feet and subject to constraints on market shares[8]. A five year programme of yearly auctions beginning in 1999/2000 is envisaged. The auctions are open to all bidders in contrast to the original Hornsea auctions which were open only to shippers and Transco.

Ofgas did not like reserve prices but was persuaded by BGS to allow them. Setting a reserve price would help increase expected revenue but may exclude some competitors and increases the risk that unsold capacity might remain after the auctions. To counter this eventuality, BG is obliged to offer unsold capacity at subsequent auctions in 2000, 2001 and 2002. Five year unsold gas will be offered at subsequent one year auctions. In practice it may be difficult to distinguish reserve prices designed to encourage high bidding from those which seek to establish monopolistic prices.

BG's proposal was for the auction to be of bundled amounts of capacity, injectability and deliverability in the first (1999) auction, but for there to be the possibility of

[7] The bundles differ between facilities. Thus for Hornsea (Rough) bundled storage consisted of 1(1) kWh/day of deliverability plus 17.948718 (66.593407)of space plus 0.110769 (0.351648) kWh/day of injectability. Rough has a relative advantage in terms of both space and injectability.

[8] In order to prevent cornering of the market, a restriction of between 15 and 20% of capacity rights was imposed on any one bidder. This might pose difficulties for larger users short of supplies.

separate auctions in subsequent years. However, since bundled bids could be unbundled for sale in a secondary market there seems no valid reason for bundling in the first place. Ofgas felt that unbundling would be unnecessarily complicated but if the secondary market is capable of handling unbundling, why not the primary market? A secondary market calls into question the efficiency of the primary market - bundles are not necessarily going to be obtained by those who have the highest value for each service. The seller can however benefit from a secondary market through higher revenues.

One novelty is the proposed 'use it or lose it' service whereby any capacity not being brought into use would be returned to the market. Such a service would in theory ensure full capacity utilisation. However, BG proposed minimum prices for 'use it or lose it' gas and this risks the possibility that not all capacity would be sold. Ofgas was unhappy about this proposal but was prepared to allow BG to proceed with its proposal and review it after the auction. An alternative approach would have been to impose some kind of penalty on BG if all its capacity was not used.

The credit worthiness of bidders is important for any successful auction. If a winning bid were to prove unsupportable by the bidder, the auction would have to be held again, and the cost would be the cost of the second auction plus the costs of delayed decisions faced by all bidders. BG's proposal to vet bidders at its discretion introduces an element of arbitrariness which could reduce confidence in the auction and lower average bid levels.

Any purchase of capacity in an auction has implications for use of related services principally those involved in moving and extracting gas into and from storage. Fees for these services are fixed in advance. It is difficult to see any good reason why these services should not be included in the auction since different buyers will have different requirements for services depending on the use they make of the storage.

Information disclosure is incomplete. BG argued that it should be up to the bidders whether they wished to disclose information regarding their bids. This has two unfortunate effects. Firstly it is impossible to subject the auctions to rigorous scrutiny in order to evaluate their efficiency. Secondly, lack of full information creates greater uncertainty for bidders in subsequent auctions. If revenue raising is an objective all information possessed by the seller should be published.

The Rough and Hornsea auctions were held between 22 March and 22 April 1999 and some details of the outcomes are given in Table 2. From these we can make an informal evaluation of the efficiency of the auctions.

Table 2

Outcome of the 1999 Rough and Hornsea Auctions 22 March to 22 April 1999

Auction	Five Year Hornsea	Five Year Rough	One Year Hornsea	One Year Rough
Reserve Price (p/kWh)	2.50	10.98	2.50	9.89
Clearing price	3.41	nk	nk	9.89
Weighted Ave. price	5.63	11.07	5.66	9.97
Revenue expected	£2.5m	£25.0m	£2.5m	£22.5
Revenue estimated	£3.41m	£25.0m	£3.41	£22.5
Capacity sold (mn kWh)	1,747.25	3,181.5	1,747.25	12,284.68
Percent sold	50%	11%	50%	41%
Bidders - total	16	6	18	18
Bidders - successful	10	6	9	17

Sources: Ofgas (1999d), BG Storage

On efficiency grounds it would appear as though the 1999 auctions were quite successful. 100% of the Hornsea capacity was sold (the sum of the two tranches of 50%) together with 51% of the Rough capacity. The improvement in Rough capacity sales amounted to 5% over the close of the 1998 Rough tender. Bidder interest was sustained throughout all but one of the auctions and ranged between 6 and 18 bidders. Nevertheless, although almost all bidders in the Rough auctions were successful, only between 50 and 63% were successful in the Hornsea auction.

The fact that the Hornsea auction was oversubscribed while the Rough auction was undersubscribed suggests that the bundles of services sold were not optimal. Rough's formula gave greater weight to storage space and injectability while Hornsea's formula favoured deliverability. The implication of unsatisfied demand for deliverability suggests that an unbundled auction would yield greater bidder welfare in future auctions.

In terns of the revenue consequences of the auctions, whilst the Hornsea auction if evaluated at the market clearing price yielded £6.82m compared with £5m reserve value (Ofgas, 1999a), Rough realised only £24.23m out of its £47.5m reserve value, leaving the overall sale at only 59% of the reserve value. Of course the final revenue total will depend on the subsequent disposal of unsold capacity. If this were all to be sold at the market clearing price, the overall process would achieve a revenue for the seller 3.5% greater than reserve. Thus at this admittedly optimistic evaluation, the revenue expectations of the seller are fully protected, and the auction would not appear to have exerted a great deal of competitive pressure on the outcome.

5. Conclusions

Using auctions represents an important new development in the regulation of the formerly publicly owned utilities. It offers the prospects of achieving optimal or near optimal allocation of existing capacity and a price mechanism for establishing whether new investment is needed. Although there are varieties of auction design available most of them have highly desirable properties in the valuation of assets for rapidly changing market environments. Capacity can be allocated to users whose bids reveal that they place the greatest value on capacity thus directly improving welfare. At the same time auctions have useful revenue raising features as is witnessed by the popularity of auctions among many regulatory authorities.

The use of auctions in connection with UK gas storage has shown that auctions can be successfully organised for this important component of the gas industry. Previously considered as essentially a joint input together with transportation services, the auctions held in 1999 have clearly shown that storage can achieve higher than reserve values at auction. This suggests that there is a sufficient variety of competing uses for storage available in the independent gas sector to ensure that bidders have no difficulty in matching the incumbent's valuation. The fact that not all of the available capacity was sold, however, implies that the incumbent's valuation is too high for at least one of the facilities - the Rough field. This lends support to the argument that reserve prices should not be applied since they can be used as ways of sustaining monopolistic pricing and may exclude potential buyers.

Major improvements in the efficiency of auctions in the gas industry may be expected providing certain developments occur. First is the integration of all aspects of storage into the auction process. Reservation of part of storage, such as LNG storage, for fixed price tender is likely to undermines the auction outcomes, so that LNG should be included in future auctions. Wider adoption of auctions throughout the industry as is envisaged in Ofgas (1999c), will attract greater bidder interest. Reserve prices should be rejected since there is no evidence of the development of rings, or of other forms of collusion, against which they might be a form of protection. The type of auction design used in any case minimises the potential for collusion.

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